

## Overview of EPA's Reburn Demonstrations in Ukraine

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### Summary

Since 1992, the U.S. Environmental Protection Agency (EPA) Office of Research and Development has been closely involved in cooperative demonstrations of reburning technology for reduction of nitrogen oxides ( $\text{NO}_x$ ) in Ukraine. These demonstrations have taken place at the Ladyzhin Power Station, located approximately 200 miles south of Kiev. The Ladyzhin Power Station is a coal-fired plant with six 300 MWe wall fired wet-bottom boilers of identical design. Ladyzhin Unit 4 was the site of a demonstration of natural gas reburning and, at the time it was completed, was the largest unit on which reburning had been demonstrated. The Unit 4 project involved the EPA's National Risk Management Research Laboratory/Air Pollution Technology Branch (APTB), ABB-Combustion Engineering, the All-Russian Heat Engineering Institute of Moscow (VTI), the Ukrainian Ministry of Power and Electrification, and the Ladyzhin Power Station. Long term operating tests demonstrated 50%  $\text{NO}_x$  reduction.

Test results show  $\text{NO}_x$  reductions of 50 percent from a baseline of 600 ppm (0.82 lb/10<sup>6</sup> Btu). During testing,  $\text{NO}_x$  reductions ranged from 40 to 60 percent depending on operating conditions. These  $\text{NO}_x$  reductions were achievable at CO levels of 250 ppm or less. CO levels could be reduced to less than 100 ppm by operating at increased economizer outlet  $\text{O}_2$  levels. At 4.5 percent  $\text{O}_2$ ,  $\text{NO}_x$  was 660 ppm prior to reburn retrofit and approximately 280 ppm with reburn in service, for a 58 percent  $\text{NO}_x$  reduction with a CO concentration of 83 ppm.

The only negative impact of concern was a slight increase in carbon-in-flyash. Prior to retrofit, carbon in flyash averaged 1 to 2 percent, compared to 2 to 3 percent with the reburn system in service. This increase is within the plant's acceptable range, but efforts are being made to reduce it further.

In 1994, a project involving APTB, EPA's Office of International Activities (OIA), the Department of Energy's Federal Energy Technology Center (FETC), Energy and Environmental Research Corporation (EERC), and the Ukrainian Ministry of Power and Electrification was initiated to demonstrate a multi-fuel (natural gas, oil, or coal) reburning system in Ukraine. Following a series of site visits to other plants in Ukraine, it was determined that the site offering the best opportunity for a successful demonstration was again the Ladyzhin Power Station, with the demonstration planned for Unit 6. Design and installation of the system began in 1995, with testing beginning in 1996. The project organization has had EPA as providing funding and technical oversight, with detailed process design provided by ABB-CE on Unit 4 and EERC on Unit 6. Additional technical expertise was provided for the Unit 4 project by VTI and for the Unit 6 project by FETC, with fabrication and installation for both projects provided by the Ladyzhin plant. Coordination in both projects has been provided by the Ukrainian Ministry of Power and Electrification and OIA, and additional funding has been provided by the U.S. Agency for International Development.

A significant component of the coal reburning system is the provision of a suitable supply of pulverized coal for use as the reburning fuel. Ideally, the coal used for reburning should be of a much finer grind than that

normally supplied to the main burners, to avoid significant impacts on carbon loss. Usually, a number of options are available, depending upon the extent to which new equipment can be made available, and the manner in which reburn coal supply can be incorporated into the existing plant infrastructure.

Three options for providing coal to the reburn fuel injectors were identified:

- Utilization of the existing milling circuit -- based on the use of the existing ball-mill pulverizers and primary air and FGR fans.
- Installation of new dynamic classifiers -- on a reburning portion of the coal stream drawn from the existing ball-mills, with a new FGR fan.
- Installation of a new milling circuit -- using dedicated micronizing mills and classifiers, and a new FGR fan for the reburning coal circuit.

Plant personnel at Ladyzhin, in collaboration with the Kharkov Design Bureau, reviewed these various options, with regard to cost, equipment availability, and their technical integration on Unit 6. Pending further detailed evaluation, the plant decided to pursue the third option, and to install a separate milling circuit for the reburn coal supply. This was based on the use of two fluid-energy mills, following a system recently developed by the Kharkov Design Bureau. The fluid energy mills have a nominal capacity of approximately 15 t/hr, and would take their coal supply from the coarse coal fraction returned from the classifiers in the existing milling circuit. The new mills use steam as the motive fluid, supplied at a nominal rate of 0.3 to 0.4 lb/lb coal, and are designed to produce a very fine coal grind with 100 percent less than 150  $\mu\text{m}$ .

$\text{NO}_x$  reductions of 25-40% have been achieved compared to operation of the system without injection of reburning fuel, i.e. using only the overfire air ports added as part of the reburn system. During operation with coal as the reburning fuel, this translates to total reductions of 50% or greater relative to pre-retrofit emissions. Additional system optimization is currently underway to improve the reburn coal feed rate and the  $\text{NO}_x$  reduction capacity of the unit.